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Zinc Oxide Film on Glass Substrates by Means of Plasma Immersion Ion Implantation and Deposition

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Abstract. *This paper shows a process for coating glass with ZnO by Plasma Immersion Ion Implantation and Deposition (PIII&D). The results shows a nanostructured films with optical transmittance reached 51.8% of transmittance in visible wavelength range.*

Palavras-chave: Zinc Oxide; Nanostructures; Plasma

1. Introduction

Zinc Oxide (ZnO) is a semiconductor material, which presents many interesting characteristics to the scientific community and the electronics industry. This work reports the growth of micro and nano-structured ZnO on glass substrates by means of Plasma Immersion Ion Implantation and Deposition (PIII&D). In this process, metallic Zn is implanted and deposited on Glass surface and ZnO nanostructures are attained after annealing in rich oxygen atmosphere.
The Sanples was annalized by X-ray Diffraction, Scanning Electron Microscopy (SEM), Optical Profilometry and Optical Transmittance.

2. Methodology

The process of PIII&D was performed in a system called VAST [VIEIRA, 2010]. In this system, an argon/oxygen mixture glow discharge is first switched-on. A crucible, which is filled with small pieces of metallic zinc, plays the role of the anode of the discharge itself, being polarized by positive DC voltage. The temperature of the crucible is increased causing the vaporization of the zinc at a controlled temperature. The vapor is partially ionized due to collisions with plasma particles. Zn ions are implanted into Glass when high negative voltage pulses are applied to the sample holder. After PIII&D glass samples were annealed for 1h.at 700 ºC.

3. Results and Discussions

Figure 1 shows X-Ray diffractogram pattern for sample after annealing. The annealed sample shows only ZnO peaks. The (101) peak remained as the dominant one, but many other ZnO peaks arose, indicating that the annealing favored the oxidation of metallic Zn present in the film. Figure 2 shows SEM images corresponding to the annealed sample. It can be observed the formation of structures resembling nanothorns with random orientation and position on the surface film after annealing. It can be seen prominent change in the surface after annealing. Changes on the morphology of grown ZnO films after annealing at different temperature range were extensively discussed on the literature. The optical profilometry analisys (Figure 3) show a increase of the surface area. The high increase of the roughness and surface area was due to the formation of microstructures during structural rearrangement of the crystals shows at SEM images. Analysis of the spectral transmission of light through the ZnO film is shown in figure 3. The film is partially transparent to wavelengths in the visible range. The average transmittance was found about 51.8% to 400-800 nm range. The decrease in transmittance for wavelengths lower than 400nm can be explained by the absorption of photons with energy greater than the ZnO band gap (around 3.37 eV).

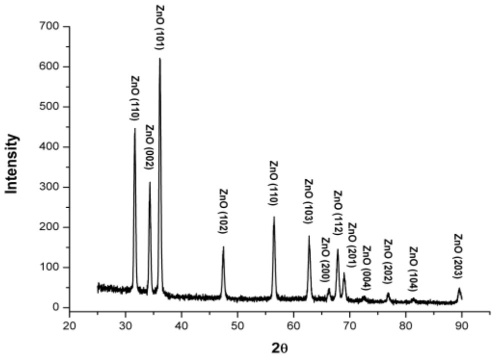

Figure 1: XRD affter annealing.

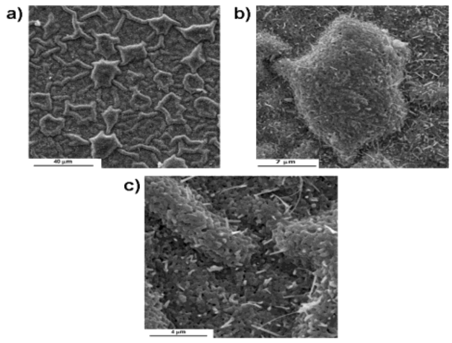

Figure 2: SEM images for samples affter annealing.

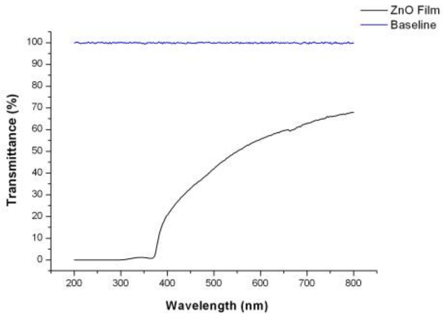

Figure 3: Measurement of the transmission of the ZnO film.

4. Conclusions

In summary, micro and nanostructures of crystalline ZnO, partially transparent in the visible wavelengths range were grown on glass substrate without the need of a catalyst of buffer layer, by means of PIII&D. The process runs in low temperature and its operation parameters are easily controlled. The samples were characterized by XRD, Optical Profilometry, SEM and Optical Transmittance, in order to infer their phase characterization, topography, morphology and transmittance, respectively. Post-oxidation stage was demanded to the achievement of micro and nanostructures and transmission in the visible range.

Thanks: CAPES, CNPq

References

Vieira, M. S. Deposition of ZnO films on Si substrate by plasma immersion ion implantation and deposition. Master Dissertation, INPE, 2010.